ON THE LINGUAL DENTITION AND GENITALIA OF PARTULA AND OTHER PULMONATA.

BY W. G. BINNEY.

I owe to the kindness of Dr. W. D. Hartman, of West Chester, Pennsylvania, the opportunity of examining numerous species of *Partula.* The specimens were received by him directly from Mr. Garrett. Their identification is that of the latter, and may be relied upon on account of his relations with Mr. Pease. Of their value as distinct species, however, I have nothing to say. So labelled were *Partula fusca*, Pease; *P. citrina*, Pease; *P. planilabrum*, Pease; *P. abbreviata*, Pease; *P. umbilicata*, Pease; *P. bilineata*, Pease; *P. amanda; P. virginea*, Pease; *P. gracilis.* Each of these were represented by several specimens still remaining in their shells. Each species was in a separate bottle, great care being taken to preserve their identity and pevent intermingling of species.

In addition to the above nine so-called species, there was one large bottle containing many specimens of the following: *Partula rosea*, Brod.; *P. formosa*, Pease; *P.? lugubris; P. varia*, Brod.; *P. compacta*, Pease; *P. Garretti*, Pease; *P.? dentifera*, Pease; *P. crassilabris*, Pease; *P. Hebe*, Pfr.; *P. protea*, Pease; *P. globosa*, Pease; *P. approximata*, Pease; *P. turgida*, Pease; *P. faba*, Martyn. As the species of the above lot were not separately indicated, the specimens are of value only as throwing light upon the generic characters of *Partula.* Especially as proving the constancy of the peculiar dentition of the lingual membrane, they serve an excellent purpose. To this end I have examined the membrane of all of the specimens in the bottle. The result of the examination will be given below.

The external characters of all the species agree. The animal is blunt before. The tail is long and gradually acuminated. There is no caudal mucus pore, no parallel furrows along the side of the foot, no distinct locomotive disk. The labial processes and the collar seem unusually developed. The anal and respiratory orifices are situated as usual in the shell-bearing Geophila. The genital orifice is close behind and below the right eyepeduncle. The tentacles are present in all the species, protruding in many specimens as fully as the eyepeduncles, in others inverted, but plainly visible on opening the head, and their position indicated exteriorly by a depression on the surface so plainly that I wonder at their having been overlooked by Férussac.

I have observed nothing remarkable in the nervous, respiratory, or alimentary systems.

The jaw, as already stated by me (Ann. Lyc. of Nat. Hist. of N.Y., XI. 45), is very thin, transparent, light horn-colored; slightly arcuate, its ends often gradually attenuated; in some specimens is a transverse, arched line of reënforcement above, but not parallel to, the cutting margin; there is no appearance of a median projection to the cutting margin; the whole anterior surface, even to the ends, is furnished with delicate, narrow, separated ribs, of the type well known in *Cylindrella*, *Macroceramus*, *Pineria*, *Gæotis*, *Amphibulima*, and many species of *Bulimulus*, their ends decidedly breaking the continuity of either margin: these ribs run obliquely to the median line of the jaw, so that at the centre they form a triangular space over which are (in one specimen of *P. gracilis*, some ten) ribs of unequal length, which do not reach the lower margin; there is, however, no distinct triangular compartment or separate piece, as in *Liguus* and *Orthalicus*. I have found this form of jaw in *P. fusca*, *citrina*, *planilabrum*, *abbreviata*, *umbilicata*, *amanda*, *virginea*, *bilineata*, and *gracilis*. I have not observed the jaw in all of the specimens of the species enumerated on p. 244, but in many of them which I have examined it proved the same as described above. The jaw differs in the various species in the more or less attenuation towards the ends, and also in the number of the ribs, thus in *virginea* and *gracilis* there are over 60, in *bilineata* I found but 50, while in one of the unnamed individuals I found only about 36. This last I have figured (pl. XIX., fig. 5) to show the general form of the jaw. The character of the ribs is better shown in the more enlarged view of the end of the jaw of *P. virginea* (fig. 11), while the disposition of the ribs at the centre of the jaw is shown in fig. 6 of *P. gracilis*.

The lingual membrane is broad. The central teeth (pl. XIX., fig. 4, of that of *P. amanda*) have a base of attachment long and narrow, squarely reflected above, the lower edge incurved, with slightly produced lateral expansions; the reflection is large and stout, with obsolete side cusps bearing decided, triangular cutting points, and a stout middle cusp bearing a stout cutting point which reaches to the lower edge of the base of attachment. The lateral teeth are longer and broader than the central tooth; they are unsymmetrical by the suppression of the inner cusp and cutting point, and the lower half of the base of attachment being thrown off towards the outer edge of the membrane, though its inner lower lateral expansion is not suppressed; the outer side cusp is well developed and bears a short distinct cutting point; the inner cusp is very stout and bears a very stout cutting point extending slightly beyond the lower edge of the base of attachment. The change from the lateral to the marginal teeth is formed by the lesser size of the reflected portion and the greater development of the inner cutting point, as well as by the blunt bifurcation of the outer cutting point. The marginal teeth have their base of attachment long and narrow, quadrangular, curving outward, prolonged above the reflection, which is small, but bears a highly developed cutting point obliquely and bluntly bicuspid on its outer edge, the inner division much the larger. The number of perfect laterals varies somewhat. I counted seven in *citrina*, eleven in *planilabrum*, ten in *abbreviata* and *amanda*, eight in *umbilicata*, *virginea*, and *bilineata*, five only in *gracilis*. The number of marginal teeth also varies, but they are numerous in all the species; in *virginea* I counted over one hundred and twenty. Excepting that some of the membranes had narrower teeth than others, I found no difference in them. They all agree (including those of the species named on p. 244) with the figure given by Heynemann (Mal. Blatt. 1867, t. i. fig. 1–1a.) of the dentition of *P. lirata.*

The genital system of one of the undetermined specimens is given on pl. XIX., fig. 1. The ovary (*ov.*) is small and stout; the epididymis (*ep.*) is short and greatly convoluted at the end nearer the oviduct; the testicle (*t.*), composed of short cœca, is small and embedded in the upper lobe of the liver in the very apex of the shell; the oviduct (*ovid.*) is long, convoluted; the vas deferens (*v. d.*) enters the prostate high up on the oviduct, not at its lower end, as usual; it runs down to the external orifice, then up to near the end of the penis sac, where it enters; the vagina (*v.*) is long, greatly swollen at the entrance of the duct of the genital bladder; the last mentioned organ (*g. b.*) is small, with a short duct which enlarges greatly before entering the vagina; the penis sac (*p. s.*) is large, long, bluntly terminating, with a decided constriction about its centre. In the other species examined, the retractor muscle is inserted at the end of the penis sac. The same general arrangement is found in the other species examined, *bilineata* (fig. 10), *fusca* (fig. 9), *virginea* (fig. 8), *umbilicata* (fig. 7), and in *abbreviata*, *citrina*, *planilabrum*, *amanda*. In *P. virginea* the constriction of the penis sac is much narrower and longer; the upper portion might be considered rather as a swelling of the vas deferens. In most of the specimens examined there were well formed shells of too full whorls in the oviduct, leading me to believe the genus viviparous. Thus I found embryonic young (usually only two) in *planilabrum*, *abbreviata*, *umbilicata*, *bilineata*, *amanda*, and *virginea*. Those less grown were enveloped in a sack. In *gracilis*, however, I found five white, calcareous eggs. They contained, however, shells of two whorls, so that even if this species actually lays the egg, it can only be at the moment the young animal is ready to break it. In many of the undetermined species, also, I found well formed eggs, and in some of them there were these eggs, and also embryonic young not protected by eggs. I suspect, therefore, that the young is actually brought forth living in *all cases*.

This closes my account of *Partula*. I add descriptions of several species of Pulmonata, whose dentition has not yet been published. As each lingual membrane is illustrated by a figure, I have not considered it necessary to give a detailed description.

Macrocyclis euspira, Pfr. (*Hyalina* of von Martens, p 72.)

Extracted from a dry specimen in the cabinet of Mr. Swift by Mr. Thomas Bland. Ann. L. N. H. N. Y., XI. 73.

Jaw low, crescentic, ends pointed; cutting margin with a decided, sharp median projection.

Lingual membrane long and narrow. Teeth arranged as in *Macrocyclis* (see ante, p. 158). There are, however, no transition teeth as in the American species, all the side teeth being true marginals of the aculeate type. Teeth 30—1—30 (pl. XXI., fig. 3). The centrals are deeply emarginate at the upper edge of their base of attachment, and have expanded lower lateral angles; they have also a well-marked simple median cusp with a decided cutting point.

The species is placed by Von Martens in *Ammonoceras*, a subgenus of *Hyalina*.

Nanina subcircula, Mousson.

Raiatea, Society Islands, Mr. Garrett to Dr. W. D. Hartman.

Jaw not observed.

Teeth (pl. XX., fig. 1) with obsolete side cusps, but distinct cutting points on the centrals. Laterals unsymmetrical as usual by the suppression of the inner cutting point, and inner lower lateral expansions to the base of attachment. Marginals aculeate, bifid.

The species is viviparous.

Endodonta tumuloides, Garrett.

Raratonga I., Cook's Isle. Received from Dr. W. D. Hartman, who received it from Mr. Garrett.

Teeth 17—1—17, with about 7 perfect laterals (pl. XXI., fig. 6). The base of attachment of the centrals is subequilateral. There are distinct side cutting points and cusps. The median cusp is long. Laterals unsymmetrical as usual. Transition formed as usual. Marginals low, wide, with one long, large, bifid inner cutting point and one small side cutting point.

Jaw not observed.

Helix astur, Souv.

New Caledonia, Mr. Thomas Bland.

Jaw (pl. XX., fig. 11) low, wide, slightly arcuate; ends scarcely attenuated, blunt; anterior surface without ribs; a wide, blunt, median projection to the cutting edge; a line of reënforcement running above, and parallel to, the cutting margin; a strong muscular attachment to the upper margin.

Lingual membrane (pl. XX., fig. 12) with 30—1—30 teeth, with about 9 perfect laterals. Centrals (*a*) with square base of attachment, well-developed side cusps and cutting points; laterals same as centrals, but unsymmetrical as usual; transition to marginals formed as usual (*b*); marginals (*c*) low, wide, with one inner, long, broad, bifid cutting point, and one outer, small cutting point; those figured (*c*) are extremes.

Helix (*Thelidomus*) **auricoma**, Fér.

Lomas de Camoa, Cuba. Mr. Arango to Mr. Bland.

Jaw arched, with blunt, scarcely attenuated ends; 12 broad ribs distributed over the whole anterior surface and denticulating either margin; no median projection to the cutting margin.

Lingual membrane (pl. XXI., fig. 5), with 42—1—42 teeth, of which about 25 may be called laterals, but the change to marginals is hardly marked, these last differing only in being smaller, in having a more square base of attachment, and in having more obtuse and more proportionally developed cutting points; there is no splitting of the inner cutting point of the marginals. The centrals have subobsolete side cusps, but decided side cutting points; the central cusp is short and stout, the base of attachment has greatly expanded lower lateral angles. Laterals like the centrals, but unsymmetrical as usual.

The dentition of this species resembles that of *provisoria* and *notabilis* of the same subgenus.

The genitalia are figured on pl. XIX., fig. 3. The penis sac (*p. s.*) is stout, rounded, with long, pointed apex; the vas deferens (*v. d.*) enters it below the apex; the retractor muscle (*r.*) is inserted in the vas deferens just before it enters the penis sac. The genital bladder (*g. b.*) is short, cylindrical, with blunt end; its duct is short and small. The penis sac enters the vagina opposite the entrance of the genital bladder.

Helix (*Carocolus*) **sagemon**, Beck.

Cuba. Mr. Arango to Mr. T. Bland.

Jaw high, arcuate, ends rapidly but slightly attenuated, blunt; cutting margin with broad, blunt, median projection; no anterior ribs.

Lingual membrane (pl. XXI., fig. 4) very long and narrow, with 36—1—36 teeth, the transverse rows of teeth being unusually oblique. The change from laterals to marginals is so gradual that it is difficult to say how many of the former there are. Centrals with base of attachment long, constricted at the middle, expanded above and with greatly produced lower lateral expansions; reflection large, with obsolete side cusps and no side cutting points, and with a very broad, short median cusp, bearing a short, widely expanded, square cutting edge (as it cannot be called a *point*). Laterals like the centrals, but unsymmetrical as usual, and with an unsymmetrical cutting edge larger than in the central tooth. The cutting edge becomes more developed as the teeth pass off laterally, in proportion to the base of attachment and the cusp also. Thus the marginals become formed without any splitting of the inner cutting point, or any development of a side cusp and cutting point. This is better shown in the figures than can be expressed in words.

The genitalia of this species is figured on pl. XIX., fig. 2. The testicle (*t*) is small and imbedded in the upper lobe of the liver; the epididymis (*ep.*) is long and greatly convoluted near its junction with the oviduct; the accessory gland (*acc.*) is composed of several tubular cæca of unequal length; the ovary (*ov.*) is very large and sabre-shaped; the oviduct (*ovid.*) is narrow, but slightly convoluted; the genital bladder (*g. b.*) is large, globular, with a short, stout duct entering the vagina at about the middle of its length; the penis sac (*p. s.*) is large, with a central constriction, tapering towards the apex, where the vas deferens (*v. d.*) enters, and bearing the insertion of the retractor muscle (*r.*) below its apex; it enters the cloaca close to the external orifice.

Helix (*Caracolus*) **Arangiana, Poey.**

Cuba. Mr. Arango to Mr. Thomas Bland.

Jaw (pl. XXI., fig. 2) greatly arched, ends blunt, scarcely acuminated; anterior surface without ribs; cutting margin with a blunt median projection.

Lingual membrane very long and narrow (pl. XXI., fig. 1), with 33—1—33 teeth, of same type as in *H. sagemon* (see above). The lower edge of the base of attachment appears delicately fringed.

Genitalia as in *H. sagemon* (see above).

Helix (*Pomatia*) **Sieboldtiana, Pfr.**

Japan. Received from Dr. W. D. Hartman.

Jaw high, arched, ends but little attenuated, blunt; anterior surface with eight stout, separated ribs, denticulating either margin; no median projection to the cutting margin.

Lingual membrane long and narrow (pl. XXI., fig. 8); teeth 39—1—39, with 21 perfect laterals; centrals with base of attachment long, narrow, the lower lateral angles somewhat expanded, but blunt; median cusp long, stout, cutting point stout, blunt, not reaching the lower edge of the base of attachment; side cusps obsolete; no side cutting points. Laterals like the centrals, but longer and wider, and unsymmetrical as usual; the fifteenth lateral has a side cutting point. The transition to marginals formed as usual by the greater proportional development and splitting of the cutting point. Marginals low, wide, with one broad, oblique, bluntly bifid cutting point, and one short, side cutting point.

The species is placed by Von Martens in *Acusta*, a subgenus of *Nanina*, judging from shell alone.

Helix convicta, Cox.

Australia. Received from Dr. Cox by Dr. W. D. Hartman.

Jaw high, arcuate, thick; ends but little attenuated, blunt; no median projection to cutting edge; anterior surface with 7 separated, stout ribs.

Lingual membrane (pl. XXI., fig. 7) with 30—1—30 teeth, with 10 laterals. The centrals and inner laterals have no side cutting points. Transition to marginals as usual (see last species). Marginals low, wide, with one short, broad, bifid inner cutting point, and one small, side cutting point.

Helix (*Dorcasia*) pyrozona, Phil.

"Outside the great wall of China." Lieut. Wild, U. S. N., to Dr. W. D. Hartman.

Jaw as in Pomatia (see above, *H. Sieboldtiana*). Ribs few, stout.

Lingual membrane (pl. XX., fig. 8), with 28—1—28 teeth, with 10 perfect laterals. It is difficult to distinguish any cutting points on the obsolete side cusps of centrals and inner laterals. The general characters of the teeth are as in *H. Sieboldtiana* (see above).

Stenogyra hasta, Pfr.

Cuba. Received from Mr. Bland.

Jaw (pl. XX., fig. 2) low, arcuate, ends somewhat attenuated, blunt; no median projection to cutting margin; anterior surface with numerous delicate striæ.

Lingual membrane (pl. XX., fig. 3) as usual in the genus (see ante, p. 187). There are 18—1—18 teeth.

The species was formerly described as a *Balea*. This examination of the jaw and dentition shows its correct position to be in *Stenogyra*.

Macroceramus turricula, Pfr.

Lomas de Camoa, Cuba. Mr. Arango to Mr. Bland.

Jaw as usual in the genus (see ante, p. 223). Ribs 35.

Lingual membrane (pl. XX., fig. 9) as in *M. Gossei*, Pfr. (see above), not as in *Cylindrella*.

Cylindrella (*Gongylostoma*) elegans, Pfr.

Habana, Cuba. Mr. Arango to Mr. Thomas Bland.

Lingual membrane (pl. XX., fig. 6) with 12—1—12 teeth, arranged as usual in the genus(see ante, p. 222). The base of attachment is shorter and stouter, the outer cusp of the laterals is larger and on a shorter and stouter pedicle than in *Cylindrella scæva*, figured on page 222. There are no distinct marginals, the teeth slightly and gradually changing in size as they pass off laterally, until in the extremes the two cutting points become of almost equal size and the outer one ceases to be on a distinct pedicle; the base of attachment also in the extremes is almost square.

This membrane is of interest, being the first described of the section *Gongylostoma*, whose dentition was unknown to Messrs. Crosse and Fischer.

Cylindrella cyclostoma, Pfr.

Mr. Arango to Mr. Bland. Lomas de Camoa, Cuba.

Jaw as usual in the genus, with over 70 delicate ribs (see ante, p. 222).

Lingual membrane long and narrow, as usual in the genus. Laterals 2, marginals about 8, these and centrals of same type as those figured by Messrs. Fischer and Crosse (Journal de Conchyliologie, 2d s., X.), for the group *Cylindrella*, s. s., as in *Cylindrella costata*, pl. IV., fig. 2.

The first marginal, however, surely is of same type as the laterals, though much smaller and somewhat modified in form. It appears like a transition from the one to the other.

Cylindrella (*Thaumasia*) Humboldtiana, Pfr.

Cuba. Mr. Arango to Mr. Bland.

Lingual membrane long and narrow, as usual in the genus. Teeth 8—1—8 of same type as figured by Messrs. Fischer and Crosse for *C. rosea* (Journ. de Conch., XVIII, 1870, pl. IV. fig. 4).

The species belongs, therefore, to their group *Thaumasia*.

The jaw is as usual in the genus, with about 100 ribs.

EXPLANATION OF THE PLATES.

PLATE XIX.

t. Testicle.
e. Epididymis.
ac. Accessory gland of last
ov. Ovary.
ovid. Oviduct.

p. Prostate.
v. d. Vas deferens.
p. s. Penis sac.
r. Retractor muscle of last.
or. External orifice of genitalia.
g. b. Genital bladder.
v. Vagina.

Fig. 1. Genitalia of Partula.
Fig. 2. " H. Sagemon, Beck.
Fig. 3. " H. auricoma, Fér.
Fig. 4. Lingual dentition of Partula amanda, Pease. The last figure is the extreme marginal in profile.
Fig. 5. Jaw of Partula.
Fig. 6. " " Partula gracilis, Pease.
Fig. 7. Genitalia of Partula umbilicata, Pease.
Fig. 8. " " P. virginea, Pease.
Fig. 9. " " P. fusca, Pease.
Fig. 10. " " P. bilineata, Pease.
Fig. 11. Jaw of P. virginea, Pease.

Plate XX.

Lingual dentition and jaw of:—

Fig. 1. Nanina subcircula, Mousson.
Fig. 2, 3. Stenogyra hasta, Pfr.
Fig. 4. Helix vortex, Pfr. (See p. 180.)
Fig. 5. Helix septemvolva, Say. (See p. 203.)
Fig. 6. Cylindrella elegans, Pfr.
Fig. 7. Succinea Stretchiana, Bland. (See p. 232.)
Fig. 8. Helix pyrozona, Phil.
Fig. 9. Macroceramus turricula, Pfr.
Fig. 10. Holospira Goldfussi, Pfr. (See p. 183.)
14. The extreme figure is drawn from another portion of the membrane, where the cusps are more highly developed.
Fig. 11, 12. Helix astur, Souv.

Plate XXI.

Jaw and lingual dentition of:—

Fig. 1, 2. Helix Arangiana, Poey.
Fig. 3. Macrocyclis euspira, Pfr.

Fig. 4. Helix Sagemon, Beck.
Fig. 5. Helix auricoma, Fér.
Fig. 6. Endodonta tumuloides, Garrett.
Fig. 7. Helix convicta, Cox.
Fig. 8. Helix Sieboldtiana, Pfr.
Fig. 9. Zonites minusculus, Binney. (See p. 166.)